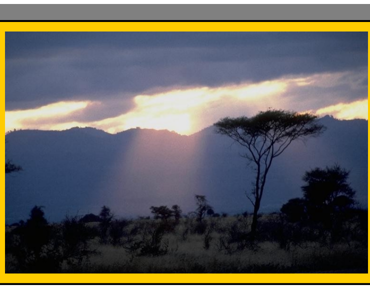
The Sun and Solar Wind: A Search for the Beginning

The Fraunhofer Lines

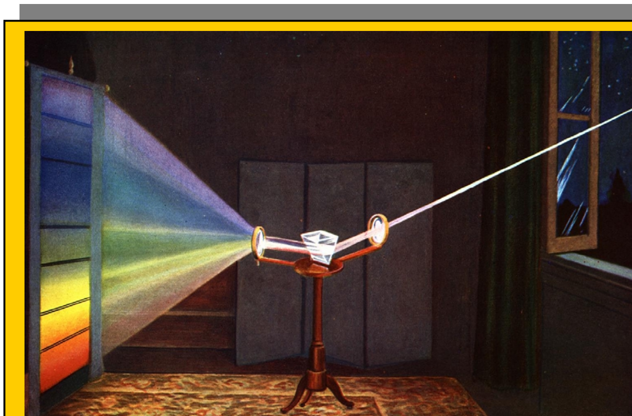
STUDENT TEXT

The text on "Electromagnetic Radiation" notes that photons may be absorbed by an atom causing an electron to jump from one orbital to another. Each jump, or excitation, is associated with one specific energy and, therefore, one specific wavelength. Through the study of absorptions of this type, it has been shown that in the "cool," wispy outer layers of the sun one can find evidence for atoms of many of the elements.



How does this work? Look at it this way. The photosphere emits radiation that covers a broad spectrum of wavelengths. For example, the visible radiation arriving at Earth contains all of the colors of the rainbow and is often called "white light" because we do not see the individual colors until they are separated from each other with, say, a prism. Now let us imagine a situation where we observe sunlight (INDIRECTLY!!) through a filter that absorbs all of the yellow and green wavelengths. What we would see is no longer white light, but rather the radiation allowed to pass through the filter—the red, orange, blue, and violet all mixed together. This light would be some shade of purple, reflecting the mixing of reddish with bluish wavelengths.

Now, let's imagine a filter that absorbs only one wavelength of visible light rather than the one above that absorbs a range of wavelengths. If we pass white light through this filter, the single wavelength will be removed from the white light and the resulting observed light would not contain that wavelength. Clearly this filter might be an atom because atoms absorb specific wavelengths of light. In effect, atoms have signatures.



A device called a spectrograph is used by solar scientists to spread out the visible portion of the sun's radiation into its components, displaying the various wavelengths as a colored ribbon ranging from violet through blue and on to green, yellow, orange, and red. The absence of a given wavelength or set of wavelengths in the spectrograph's display indicates that an atom has acted as a filter and absorbed its own characteristic wavelengths. These absences show up as a dark line superimposed on the colored ribbon. Such absences were first observed in the sun's spectrum by Joseph von Fraunhofer in 1814, and the dark lines observed are now referred to as Fraunhofer lines. The various atoms in the cool, wispy gases of the outer layers of the sun act as filters for the light emitted from deeper, hotter, and more dense regions. By analyzing the absorbed light and comparing it to the results of atomic filtering experiments here on Earth, it becomes possible to read the signature of the atom that served as a filter. Thus, it becomes possible directly to obtain information about the elemental composition of the sun.

Over the years the study of spectral lines has been of enormous importance to astronomy, not only in studies of the sun, but also celestial objects.